T10D05 - Evaporation and Intermolecular Attractions

Assessment: Conclusion and Evaluation (CE)

Name…….

In this experiment, Temperature Probes are placed in various liquids. Evaporation occurs when the probe is removed from the liquid's container. This evaporation is an endothermic process that results in a temperature decrease and is known as the heat of vaporization. The magnitude of a temperature decrease is, like viscosity and boiling temperature, related to the strength of intermolecular forces of attraction. In this experiment, you will study temperature changes caused by the evaporation of several liquids and relate the temperature changes to the strength of intermolecular forces of attraction. You will use the results to predict, and then measure, the temperature change for several other liquids. Drawing or building the structures will help you to visualize the reasons for stronger or weaker intermolecular forces of attraction. You make take pictures of your built molecules or simply draw the structures.

OBJECTIVES – (respond to them in your conclusion)

In this experiment, you will

- Study temperature changes caused by the evaporation of several liquids.
- Relate the temperature changes to the strength of intermolecular forces of attraction.
- Report the trend of homologous series found in physical properties (graphical or otherwise)
- **<u>As best you can (from materials provided) predict the boiling point of alkanes and alcohols from C1→C8 long</u>**

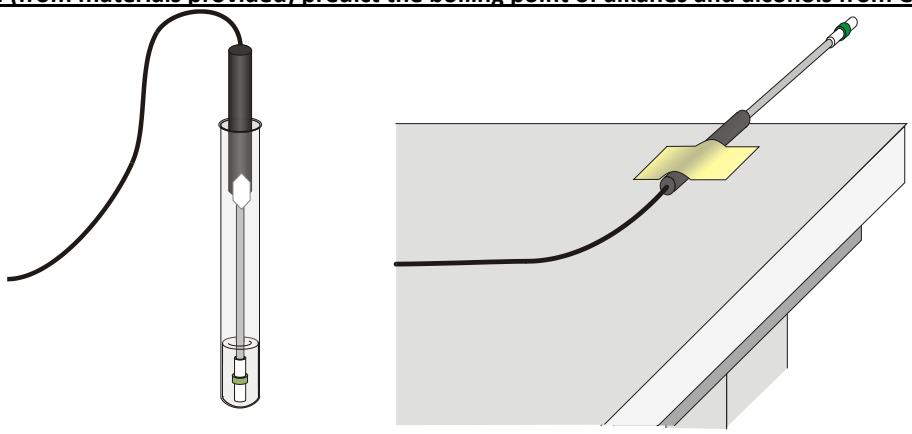

Figure 1

MATERIALS

computer
Vernier computer interface
Logger *Pro*
two Temperature Probes
6 pieces of filter paper (2.5 cm × 2.5 cm)
2 small rubber bands
masking tape
Various organic compounds

YOU HAVE DONE THIS ACTIVITY BEFORE (LAST YEAR) BUT YOU WILL DO IT AGAIN WITH A DIFFERENT PERSPECTIVE!!

PROCEDURE

1. Obtain and wear goggles! **CAUTION:** The compounds used in this experiment are flammable and poisonous. Avoid inhaling their vapors. Avoid contacting them with your skin or clothing. Be sure there are no open flames in the lab during this experiment. Notify your instructor immediately if an accident occurs.
2. Connect the probes to the computer interface. Prepare the computer for data collection by opening the file "09 Evaporation" from the *Chemistry with Computers* folder.
3. Wrap Probe 1 and Probe 2 with square pieces of filter paper secured by small rubber bands as shown in Figure 1. Roll the filter paper around the probe tip in the shape of a cylinder. Hint: First slip the rubber band up on the probe, wrap the paper around the probe, and then finally slip the rubber band over the wrapped paper. The paper should be even with the probe end.
4. Stand Probe 1 in the ethanol container and Probe 2 in the 1-propanol container. Make sure the containers do not tip over.
5. Prepare 2 pieces of masking tape, each about 10 cm long, to be used to tape the probes in position during Step 6.

6. After the probes have been in the liquids for at least 30 seconds, begin data collection by clicking Collect. Monitor the temperature for 15 seconds to establish the initial temperature of each liquid. Then simultaneously remove the probes from the liquids and tape them so the probe tips extend 5 cm over the edge of the table top as shown in Figure 1.
7. When both temperatures have reached minimums and have begun to increase, click Stop to end data collection. Click the Statistics button, , then click OK to display a box for both probes. Record the maximum (t_1) and minimum (t_2) values for Temperature 1 (ethanol) and Temperature 2 (1-propanol).
8. For each liquid, subtract the minimum temperature from the maximum temperature to determine Δt, the temperature change during evaporation.
9. Roll the rubber band up the probe shaft and dispose of the filter paper as directed by your instructor.
10. Based on the Δt values you obtained for these two substances, plus information in the Pre-Lab exercise, *predict* the size of the Δt value for 1-butanol. Compare its hydrogen-bonding capability and molecular weight to those of ethanol and 1-propanol. Record your predicted Δt, then explain how you arrived at this answer in the space provided. Do the same for n-pentane. It is not important that you predict the exact Δt value; simply estimate a logical value that is higher, lower, or between the previous Δt values.
11. Test your prediction in Step 10 by repeating Steps 3-9 using 1-butanol for Probe 1 and n-pentane for Probe 2.
12. Based on the Δt values you have obtained for all four substances, plus information in the Pre-Lab exercise, predict the Δt values for methanol and n-hexane. Compare the hydrogen-bonding capability and molecular weight of methanol and n-hexane to those of the previous four liquids. Record your predicted Δt, then explain how you arrived at this answer in the space provided.
13. Test your prediction in Step 12 by repeating Steps 3-9, using methanol with Probe 1 and n-hexane with Probe 2.

PRE-LAB

Substance	Formula	Structural Formulas	Molecular Weight

Etc……..

FYI: *This is a very generic data table. You should open logger pro and excel and make your own. This lab will NOT be submitted for IB as the random error (uncertainty) will be very small but you must still account for uncertainty numerically in order to state in your conclusion. You will complete a full error analysis. Focus should be on the CHEMICAL CONTENT involved in the experiment (CE aspect 1). Repeat the trials as many times as the class period allows.*

DATA TABLE

Substance	t_1 (°C)	t_2 (°C)	Δt (t_1–t_2) (°C)

Etc……..